



# STRATEGY FOR ANALYZING REGIONAL AND GLOBAL TRENDS IN CHILD MALNUTRITION

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## ABSTRACT

### Background:

Malnutrition among children is a significant factor that helps in generating proper monitoring technique that helps in generating progress towards the development goals that are selected during the Paris Summit for gaining a sustainable world. The development of the World Health Organisation-based methodology is derived from the regional and global trends of stunting and underweight-related problems occurring in children. The reports regarding trend analysis of the aforementioned problems for the years 2008 to 2023 are used.

### Methods:

Prevalence Data based on the reports generated by the branches of WHO located across 186 countries are extracted. Depending on Global Database that is generated based on Child Growth trends and Malnutrition rates are used. Estimation of the problem trends is created using mixed-effect methods. Random impacts that are generated across the country level and the heterogeneity that is found within the covariance structures are used. Each region of United Nations-based countries is allocated for conducting the legit transformation of the malnutrition rate over the last fifteen years.

### Results:

During the last fifteen years, a significant level of change has been found regarding the two problems of stunting and underweight. Stunting shows a decrement starting from 33.7% to 25.1% globally, with the highest decrement rate in the Northern African region, starting from 26.2% to 13.1%. Similarly, the decrement rate of underweight children existence is found to be 26.7% to 20.5%, with the highest decrement rate found in Asian countries from 35.5% to 24.7%.

### Conclusion:

The global trends of malnutrition among children under the age of 5 are uneven in different regions of the world. More concerted interventions of the national and international authorities are required to meet the Sustainable Developmental Goals that have helped reduce the rate of child malnutrition over the last 15 years.

**KEYWORDS:** Malnutrition, Underweight, Stunting, Regional, Global

## INTRODUCTION

Child malnutrition is one of the most important factors in the world including height and weight-related issues among children. The aftermath of chronic malnutrition in the lives of children creates a significant threat to the improvement of the future of a nation. The burden of "under five stunting" has decreased from 203.6 million in 2000 to 149.2 million in the year 2020<sup>1</sup>. Ethiopia, the "largest and most populous country" in the sub-region of Saharan Africa has experienced the greatest rate of child malnutrition in the world. The government and other stakeholders have effectively progressed in regulating malnutrition among children. Achieving the goal of zero malnutrition among children, it is quite impossible to understand the "epidemiology" of under-five stunting and different types of disparities in a specific region. As per the studies, annually around 2.4 million children under the age of five die from malnutrition and this type of disorder is referred to

as "Coexisting Forms of Malnutrition"<sup>2</sup>. This study deals with the methodological development that is applied by the "World Health Organization" to estimate the global report from 2008 to 2023 related to the malnutrition of children<sup>3</sup>. This particular analysis of different information is an updation of the "earlier usage of trends" and the upgraded information to evaluate the subsequent of malnutrition children within the world.

## DATA AND METHODOLOGY

Estimation of the trends regarding malnutrition across different regional and global portions needs proper data in determining the underweight prevalence among children. Based on <-2 range of standard deviation that is found from the World Health Organization International Reference Population, a critical study is conducted from the global database of the Joint Child Malnutrition Report of UNICEF and World Health Organisation<sup>4</sup>. A total of 186 country-based reports

of representative surveys of the prevalence of underweight children are available. These countries include almost 150 million children who are estimated to be stunted under age 5. Almost 100 countries show that there remain almost 45 million children who are considered to be wasted, bearing lesser weight compared to their height under the age of 5, and 37 million such children are found to be overweight 4. Among these reports, and the official statements that are found on the websites of WHO and UNICEF, show that almost 50% of the children facing death before the age of 5 years are found to be a result of malnutrition.

Among these countries that are found to bear serious malnutrition-related issues for both children and adults. The economic, and social along with the medical implications of the global malnutritional burden are found to be spread along different levels of regions, including the families and the individuals. For the communities along with the countries, the data are collected and the country-based data are divided into different clusters. Depending on such types of data, different regional portions of the different continents are encountered. A database is generated for understanding the interrelationship of the variables including various regions, sub-regions, and country-based surveys conducted by the UNO<sup>5</sup>. Various sample sizes present in the country-based reports found in the National and International Malnutritional Children death profile create a comprehensive list for the national prevalence of necessary information. The sources that are included in the prevalence ratio of underweight children ratio generation based on the country's population are used for creating such types of data<sup>6</sup>. These lists include the interrelationship between the underweight and stunting presence-based sample collection technique and their nutritional strategic involvement that have been used for dataset orientation and statistical analysis conduction.

## Statistical Analysis

### *Developing country regions-based malnutrition trends*

Different types of models and frameworks are used to analyze the information at different levels of countries and that effect redeemed the countrywide interchange rate of malnutrition children. This statistical model is used within the analysis of different types of information related to the malnutrition effect among children<sup>7</sup>. The two major components of this model are the countries and the reports of the survey. Considering the reports of the sub-regions of different countries, this analysis becomes suitable for the explanation of different effects on the sub-regions of countries. Analyzing different types of official reports of "The World Health Organisation", "Global Nutritional Report", "Demographic and Health Survey" and "Food and Agricultural Organisation" this study gathers information from different regions-based and analytical approaches of countries to select the demographics affected for the malnutrition<sup>8</sup>. The usage of different types of models and techniques for the analysis helps the researcher to investigate the proper strategy for the analysis of developing country-based malnutrition trends.

Region-based trends of malnutrition have experienced the higher rate of malnutrition that affects the children most,

with the approximate affected rate being one-third, having the highest stunting rate. On the other hand, Europe, Central Asia and Northern America have experienced a lower rate of stunting. South Asian countries have two out of five children with stunting and Sub-Saharan Africa has resulted in the same count for the disorder in nutrition among children. Latin America and the "Caribbean" have faced the issues of high rate of stunting among children with a rate of 11.5%<sup>9</sup>. Apart from that, the Middle East and North Africa have overweight issues, that affect children around 11.5% of<sup>10</sup>. East Asia and the Pacific region have been affected largely by the issues of overweight children, approximately 11 million children around the Asian and Pacific region.

The most important advantage of this mixed model method is the correlation and the "heterogenous" model and normality's for both the effects. This study considers three important steps for the analysis of the covariance including the "compound symmetric", "unstructured" and the "autoregressive." The "Compound Symmetry model" shows the interpretation of individual countries and creates a regulation for creating a "particular slope" for all the countries based on a particular time<sup>11</sup>. Besides this, the "unstructured model" allows all the countries for the maintenance of a particular slope based on a particular time. The "Auto-Regressive" model of "order 1" shows the "correlation" between the observation of the countries' structure-wise factors and the increasing rate of the country based on time<sup>12</sup>. The estimation of the years 2008 to 2023 and the information stabled under this period create "maximum likelihood estimation" for the analysis of "fixed-effect estimation" of "standard Deviation." The usage of Fitting is for maintaining the "logistic transform" of "prevalence."

### *Prevalence estimation of malnutrition children death index for developing-country regions*

The prevalence estimation rate among the children and their mortality rate depends upon various factors including the "nutritional status" of children around the country, "healthcare access", and "socio-economic condition" of the country, impact on the nutritional issues of children. Different types of data sources are used within this analysis including the "demographic and Health Surveys" to gather information related to the nutritional benefit of children, morality rate and the healthcare analysis of them<sup>13</sup>. The "Multiple indicator cluster survey", conducted by UNICEF is used to collect information related to the health and well-being of women and their children. World Health Organisation provides statistics related to "global health" including the nutritional disorders of children and their mortality rate in different countries<sup>14</sup>. The most important indicators that are used within the analysis are "stunting" to measure the difference between the lower rate of height with the growing age and "wasting" to identify the difference between weight and height ratio related to the nutritional disorders among children and the issues for the result of those risks.

The "morality rates" among children provide the views of causes behind the nutritional issues among children, the risks for causing the nutritional issues among them, and the role of

malnutrition upon the mortality rate of children. Different types of statistical analysis such as “regression analysis”, “Bayesian Model”, and “Risk assessment model” consider different factors of healthcare and issues in children’s nutrition<sup>15</sup>. Sometimes, the rate of the sub-regions and the sum of the total children can differ and the usage of the prevalence of the “sum of the estimated numbers” of different regions is used for the collection of particular data. The population required for the analysis is under 5 children as they are affected population of malnutrition in most of the developing countries.

#### ***Trends regarding children malnutrition and their impact present in different developed nation***

Different ends in the developed nations are important for the measurement of the nutritional issues among children. The socio-economic factors and the measurements of the healthcare regulations of the country. Among the various trends, “obesity” and “overweight” are the most important trends for the measurement of “child malnutrition.” Consumption of higher rate of calories in their food, “low-nutrient foods”, “sedentary lifestyle”, and “limited rate of physical activities” affect the nutritional disorder among children. The obesity rate among children is increasing in the United States, Canada, and Australia along with the United Kingdom<sup>16</sup>. The lower rate of “income security” and “food security” in developed nations including the “lower rate of income” among the different regions impact the overall nutritional level of children<sup>17</sup>. Apart from these, nutrition deficiencies in food products are another important trends of malnutrition among children in developed nations. Different types of policies and government-aided programmes for the development of healthcare and public health development are important factors for the nutritional deficiencies among children in developed nations.

#### ***Global malnutrition children death prevalence estimation***

The regional estimation for measuring the global prevalence by using a similar kind of methodology for providing the description based on different regions and the impacted countries of developed nations. All numbers of children within the world are adopted for the measurement of the prevalence of the developed nations of all countries. The “prevalence estimation” using the “simple linear regression” is used for the developed countries to obtain the estimation of the rate of prevalence and the “standard error” of the collected information among countries<sup>18</sup>. Malnutrition remains one of the most important issues among developed nations, affecting the mortality rate of children worldwide. The corresponding data set for the measurement of different information related to the malnutrition rate among children within the world has been collected for the regional and global trends associated with malnutrition.

## **RESULTS**

The statistical report represents the relation between the unstructured rate, the “compound symmetry” and the “autoregressive” rate for the depiction of the countrywide rate of “stunting” and “underweight” rates among children. Throughout interests, the influential trends are developed based on the straight linear variable trend, which acts as the main

way for easy incorporation of linear trend-based deviations. Specification of second-degree based higher polynomial terms creation acts as the main way of non-linear relationship creation among examination of the different regional analyses<sup>15</sup>. All the country-based underweight children-related information is not found and the incorporation of stunting-based prevalence data in the model has been highly problematic. The countries that are included as random impactful regions for the establishment of the models regarding country-based data assumption are used. Exploitation of influences development of common operations related to underweight prevalence and stunting depending on the sub-regional estimation are created through the specification development.

In the case of stunting, the 10-year gap between 2012 and 2022, shows that 37.8 million children belonging to the low-income range used to suffer from stunting, and the gradual increment of malnutrition among children has raised the rate to 38.4 million during the year 2022. Similarly, the lower middle class and upper-middle-class people are significant levels of sufferers regarding the issue of stunting. In the year 2012, the affected children belonging to lower-middle-class families were 119.3 million, but the global financial growth during the last ten years has reduced by almost 20% and the present rate is 94.6 million in 2022 as shown in **Figure 1<sup>4</sup>**. The problem of malnutrition is less present among the people belonging to the stage of rich and upper-middle-class categories. On the other hand, another typical problem found among children as an impact of malnutrition is underweight. However, astonishingly the problem is highly found among children patients belonging to the lower middle class and upper middle-class people. The rate was found to be 14.3 million 10 years ago and now the value has changed to 15.3 million. However, the rate has decreased among upper-middle-class people from 13.9 million to 12.9 million as mentioned in **Figure 2<sup>4</sup>**.

## **DISCUSSION**

The methodology-based primary precision generation and accurate estimation-based progress development have helped the researcher in developing child malnutrition reduction progress anticipation based on sub-regional, cluster-based regional and global stages of discussion. The methodological elements that are taken under consideration are the linear trend present in the country-based population and their weight estimation for different subregions. Moreover, the Ascending order of aggregation of the weights starting from the sub-regions to the global regions is generated through random intercept-based slope calculation that allows data for reasonable result development<sup>19</sup>. Reasonable result development has required the generation of suitable simplification of data depending on random intercept creation. Along with these, all the available country-based data are utilized irrespective of data concurrency quality, and the countries that have no continuation in data set development, are assuredly generated based on predictive calculation. An explicit, multilevel model of statistical quotients related to each variable is created and the value of delta method-based approximation standard error is calculated.

A significant number of advantages are found against the existence of these methodological approaches, and those have

helped in the development of a multilevel modelling-based standard calculation approach. The software that is mainly used for the development of these models has been generated during the last decade. The structural specifications have been developed through the models across different randomly affected levels that lead them towards the involvement of residual dependency, created through a covariance structure. An explicit statistical model refers to the generation of assumptions and feature-based postulation of the variable relational model. A clear examination of these relations has been done for generating the model-based tables.

Regions	Unstructured	Compound symmetry	Autoregressive
<b>Stunting</b>			
Africa	61.3	63.1 ✓	62.2
Asia	76.6	106.8 ✓	Did not converge
Latin America & Caribbean	35.1	43.5✓	Did not converge
<b>Underweight</b>			
Africa	71.6✓	98.2	79.25
Asia	53.6	57.8✓	Did not converge
Latin America & Caribbean	30.7✓	46.1	Did not converge

**Table 1: AIC a Statistics for underweight and stunting**

All the available country data points are utilized depending on the data point-based country inclusion. Estimation of prevalence has become easier for precision and accuracy-induced data point generation. The country-based datasets estimation creates a utilization way for contribution generation towards the time-dependent progress estimation<sup>20</sup>. All the data sets that are gathered from the survey years are similarly impactful in generating the desirable datasets. The above table shows that the African region includes 61.3% of children under the age of 5 who are suffering from different types of malnutrition that induce stunting. On the other hand, the range increases up to 63.1% approximately which shows the highest possibility of children suffering from stunting in the African region. On the other hand, the average range of the stunting victims is found to be 62.2%. Similarly, the Asian region shows a stunting variability of 76.6% and 106.8%, but the convergence could not be found due to the unavailability of data.

Latin American and Caribbean regions are two important regions that used to show the earlier high rate of stunting and underweight, now show a decreased rate of stunting with a showcase of 35.1% and 43.5% stunting. On the other hand, a sub-regional monitoring-based study has shown the rates of underweight people residing in different regions that include 71.6% and 98.2% lower and higher range of underweight people existence in Africa as mentioned in **Table 1**. On the other hand, the Asian regions show a difference between 53.6% and 57.8% of such children. Similarly, Latin American and Caribbean regions include a lower range of 30.7% and a higher range of 46.1% of stunting patients.

UN Regions and Stunted (in millions)	%Stunting				No.			
Sub-Regions	2008	2013	2018	2023	2008	2013	2018	2023
Africa	35.8	37.2	34.3	34.5	38.7	40.8	44.9	49.2
	33.4–40.6	33.1–39.1	32.6–38.9	31.6–37.9	35.5–43.6	38.5–45.1	41.2–48.2	44.3–52.3
Eastern	44.1	45.5	44.3	42.9	13.8	16.3	18.4	23.6
	36.7–52.8	37.9–51.4	37.8–51.3	37.5–51.3	13.1–18.8	14.6–20.4	16.9–22.4	18.4–25.1
Middle	42.1	40.9	35.8	39.8	5.8	6.9	6.4	7.7
	34.2–50.1	34.8–48.8	34.5–41.2	32.1–39.7	4.8–6.9	5.9–7.1	6.2–7.6	6.9–8.7
Northern	26.2	22.8	22.9	13.1	2.8	7.1	9.6	8.2
	21.4–34.7	18.1–31.7	16.8–28.9	13.1–26.7	2.5–5.0	1.6–8.4	2.1–7.2	7.6–9.6
Southern	24.6	24.0	26.7	25.4	1.9	1.8	1.7	1.6
	23.6–27.9	22.7–27.1	21.4–28.9	20.2–28.7	1.5–1.7	1.2–1.6	1.9–1.8	1.3–1.9
Western	34.6	33.9	32.1	32.3	10.6	11.9	12.8	13.5
	28.5–41.7	29.8–37.6	30.5–35.1	28.5–35.6	8.7–12.5	10.5–13.9	11.1–13.9	12.5–15.6
Asia	40.2	35.7	30.2	25.4	154.7	130.9	108.8	93.4
	39.6–43.5	31.8–39.8	27.8–33.2	22.3–28.8	144.9–163.2	120.7–141.9	98.7–110.2	81.9–110.8
Eastern	30.9	21.1	15.8	10.2	38.5	22.5	16.0	8.5
	28.9–35.3	20.2–22.7	13.6–15.9	9.3–10.7	35.9–39.1	22.3–24.7	14.3–16.1	8.8–10.2
South-central	51.2	46.2	38.0	35.5	89.0	80.0	73.5	63.5
	45.2–57.4	40.1–50.4	34.6–45.7	29.1–40.3	79.1–96.7	72.1–90.1	62.1–81.5	53.4–74.5
South-eastern	41.6	36.5	32.2	27.9	24.9	20.3	19.1	19.3
	33.7–50.1	29.4–44.1	25.1–39.8	21.2–35.4	19.1–28.9	17.5–26.4	14.1–22.9	11.4–19.8



Western	25.1	21.9	18.1	16.2	5.1	5.3	4.1	4.7
	20.1–30.2	15.8–30.2	10.1–30.2	7.9–30.1	4.1–6.5	3.9–6.7	2.8–7.9	2.1–7.5
Latin, America & Caribbean	18.9	12.9	10.7	13.8	11.0	9.8	8.6	8.5
	13.7–23.1	11.4–20.1	9.2–18.2	7.1–16.7	7.5–12.7	6.1–11.4	5.1–10.1	3.1–9.4
Global	33.7	29.5	29.7	25.1	203.5	191.5	165.9	147.1
	29.7–44.6	23.1–40.1	17.9–35.7	12.8–31.5	195.6–217.4	172.1–194.5	152.4–175.6	136.3–161.8

**Table 2: Estimated Prevalence and Numbers of Stunted Pre-School Children 2008–2023 with 95% CI**

The Table number 2 shows the estimation of fifteen years of the Stunting percentage and the number of stunted children. In Africa, the stunting percentage was 35.8%, 37.2%, 34.3% and 34.5% in different regions within the years 2008, 2013, 2018, and 2023. Besides this, the number of stunted in Millions was 38.7 million, 40.8 million, 44.9 million and 49.2 million in the last fifteen years. In Asian countries, the percentage was 40.2%, 35.7%, 30.2% and 25.4% stunting percentage and the number was about 154.7 million, 130.9 million, 108.8 Million, and 93.4 Million as per the data of last fifteen years. The rate of stunting

percentage is decreasing and the number of stunted children is also decreasing by a significant number.

the global rate of the stunted percentage was 33.7% in 2008, 29.5% in 2013, 29.7% in 2018, and 25.1% in 2023. On the other hand, the numbers of stunted in global countries were 203.5 million, 191.5 million, 165.9 million, and 147.1 million. The decreasing rate of stunting shows the increasing rate of malnutrition among children worldwide.

UN Regions underweight (in millions)	%Underweight				No.			
	2008	2013	2018	2023	2008	2013	2018	2023
Africa	24.7	23.5	24.1	24.4	25.4	27.5	30.1	34.9
	21.2–26.7	21.7–26.2	21.7–26.9	22.1–26.0	22.8–28.5	25.7–30.5	28.9–33.5	31.2–37.9
Asia	35.5	31.2	27.9	24.7	132.1	115.4	102.9	89.4
	31.7–38.5	27.8–35.1	24.0–31.7	20.8–28.8	119.2–144.7	102.7–129.8	87.3–115.8	74.5–103.4
Latin, America & Caribbean	8.5	7.5	6.4	5.1	4.5	4.9	3.5	2.7
	6.2–11.8	5.1–9.7	4.5–8.2	3.4–6.9	3.5–6.7	2.3–5.1	2.5–4.7	1.7–3.9
Oceania	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Global	26.7	24.1	22.4	20.5	163.6	149.9	136.1	127.3
	24.1–28.2	22.4–26.4	19.2–24.9	18.1–22.7	150.4–178.6	135.2–163.4	122.3–150.7	112.0–141.8

**Table 3: Estimated Prevalence and Number so funder weight Pre-School Children 2008–2023 with 95% CI by UN Regions and Sub-Regions**

Eastern Africa experienced the percentage of stunted 44.1% in 2008, 45.5% in 2013, 44.3% in 2018, and 42.9% in 2023, showing the fluctuation rate among the percentage of stunted children due to malnutrition. This region of Africa had experienced several stunts as shown in Table 2 were 13.8 million, 16.3 million, 18.4 in 2028, and 23.6 in 2023. This rate shows the increasing rate of stunts among children, affects their growth and immune system by creating different types of diseases<sup>21</sup>. The middle portion of the African countries faced the percentage of stunted children were 42.1% and 40.9% in 2008 and 2013 along with 35.8% in 2018 and 39.8% in 2023. On the other hand, the number of stunted in the middle African countries was 5.8 million and 6.9 million in 2008 and 2013 with 6.4 million and 7.7 million in 2018 and 2023. The rate of the middle African countries shows the difference between the percentage rate and the number of stunting among children.

The South-central Asian countries experienced a huge gap between the rate of percentage of stunted children and the number of stunted within the last fifteen years. In 2008, the percentage was 51.2%, 46.2% in 2008 and in 2023 with the

percentage of the year of 2018 and 2023 of 32.2% and 27.9%. Apart from that, these countries experienced 89 million stunted in 2008 and 19.3 million in 2023. Compared to the global rate of percentage of stunted children, Asian countries were at the highest place and African countries were next to them as per the information in Table 2. Malnutrition among children has affected their weight and due to that effect, children have to suffer from being underweight despite their age<sup>22</sup>. Various types of factors including the nutritional level of the food products, the availability of food within the country, and the maintenance of hygiene while preparing and serving food effect the overall health of children around the world.

Table 3 shows the difference between the percentage rate of children and the number of children under the range of underweight. In African countries, the percentage of underweight children was 24.7% in 2008, 23.5% in 2013, 24.1% in 2018, and 24.4% in 2023, shows the fluctuating rate of the percentage among children in African countries. On the other hand, this country experienced several underweight children as explained in Table 3 25.4 million in 2008, 27.5 million in 2013, with 30.1

million and 34.9 million in 2023. The increasing number of underweight children shows that African countries were the most affected countries of malnutrition<sup>23</sup>. Despite different types of projected policies for the improvement of children's healthcare and public health systems in African countries, they have experienced various types of issues related to malnutrition and health problems in children. Underweight children have various types of issues in their health and due to that, they get difficulties in their growing process.

Asian countries experienced 35.5% underweight children in different regions in the year 2008, and 24.7% in 2023. Among various countries, 132.1 million children were underweight compared to their age in 2008 and 89.4 million children were underweight as per their age. The global rate of underweight children was 26.7% in 2008, 24.1% in 2013, and 20.4% in 2018, with 20.5% in 2023. The number of children underweight was 132.1 million in 2008, 115.4 million in 2013, and 102.9 million in 2018, along with 89.4 million in 2023 in Asian countries. The global rate of underweight percentage was 26.7% in 2008, 24.1% in 2013, and 22.4% in 2018 along with 20.5% in 2023 of the underweight children. The poverty rate within the world affects on the nutritional rate among the population. Along with the insecurity of food related to the proper maintenance of nutritional effects and hygiene and healthcare among children<sup>24</sup>.

The economic factors and the generation of income among the population affect the development of the health care system of children within the world<sup>25</sup>. Different government policies and programmers are there for the implementation of different types of healthcare generated programme for the development of the health of children in developed nations.

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